

Great Homes Checklist / Energy-Efficient Design and Construction

Energy Center fact sheet

10/2003

A whole-house "systems" approach to design and construction is recognized as the appropriate method of developing energy-efficient and sustainable homes. A systems approach considers the interaction between the site, building envelope, mechanical systems, occupants and other factors. The system approach recognizes that features of one component of the house can greatly affect others.

This design and construction checklist was developed to help housing designers and builders take the first steps toward a whole-house design approach and the implementation of energy-efficient construction practices. The checklist presents simple and clear guidance on energy improvements that can be readily addressed now by most housing providers. The checklist purposely focuses on wood-frame construction and limits itself to mainstream technologies. Questions should be directed to the Missouri Department of Natural Resources' Energy Center, P.O. Box 176, Jefferson City, MO 65102, Phone: (573) 751-3443, 1-800-361-4827, Fax: (573) 751-6860, E-mail: energy@dnr.state.mo.us

Foundation

A. Drainage:

- ❑1. Establish a foundation drainage system adjacent to the entire perimeter of the footing — use 4-inch perforated drain, 4 inches of gravel cover, and filter fabric.
- ❑2. Establish drainage swales as needed.
- ❑3. Grade slopes 5 percent or more away from all sides of the house for at least 5 feet.

B. Slab:

- ❑1. For a house with a slab, provide a capillary break under the slab — use 4 inches of gravel covered by a 6-mil polyethylene vapor barrier.

C. Crawlspace:

- ❑1. Install a 6-mil polyethylene ground cover with 100% coverage — overlap seams 2 feet and *lap* the foundation wall 12 inches.

- ❑2. Close crawlspace vents after making sure the crawlspace is dry — use manual rather than thermostatically controlled vents.

Framing

A. Exterior walls:

- ❑1. Use insulated corners (two-stud or equivalent) to improve insulation coverage — use drywall clips or vertical 1" x 4" nailer (Detail B).
- ❑2. Use insulated partition intersection options to improve insulation coverage — use drywall clips or vertical 1" x 6" nailer (Detail B).
- ❑3. Use insulated headers (Detail B).
- ❑4. As permitted by code, limit the use of blocking to improve insulation coverage.
- ❑5. Use rigid board insulation in place of structural sheathing in non-corner areas — fasten with plastic-capped nails.



- ❑6. In 2x4 framing, consider using continuous structural sheathing topped with continuous rigid board insulation. An alternate is 2x6 framing using continuous structural sheathing. Note that both require interior trim jamb extensions on all windows and exterior doors.

B. Roof/attic:

- ❑1. Use raised heel or oversized (cantilevered) trusses or a raised top plate to allow for complete attic insulation coverage over the exterior walls with a 1-inch ventilation channel.
- ❑2. For cathedral ceilings, use scissor trusses or frame it to provide adequate clearance for recommended insulation levels with a 1-inch ventilation channel.
- ❑3. Use 2- to 2.5-foot overhangs to shade *south-facing* windows in mixed and hot climates — some marginal benefit is also obtained for windows facing east and west.
- ❑4. Ventilate the attic using continuous soffit and ridge vents.
- ❑5. Locate the attic access hatch or pull-down stairs in unconditioned parts of the house (e.g., carport, garage, gable end of the roof) rather than inside the house —provide a locking mechanism for security.
- ❑6. If an attic access hatch is used, construct it with a rigid frame (e.g., use 1" x 4" framing rather than molding) that can be weatherstripped and with a cover that will not warp (Detail I).

Air Sealing

- ❑1. Use silicone or one-part urethane caulk, spray foam, sheet goods — e.g., rigid board insulation, plywood, drywall, polyethylene sheeting, housewrap — and other materials as identified below.

A. Before drywall is installed:

- ❑1. Seal between the bottom plate of exterior walls and the subflooring during construction — use a double

bead of caulk or durable gasket (sill seal) (Detail A).

- ❑2. Seal the inside edge of the bottom plate of exterior walls to the subflooring after the frame walls are erected (Detail A).
- ❑3. Seal the band joist of a multistory home or a home with a conditioned basement— seal between the band joist and the top plate or sill plate and between the band joist and subflooring during construction, or seal all the seams between the band joist and top or sill plate, subfloor, and floor joists after construction (Detail A).
- ❑4. For bathtubs on an exterior wall, insulate the exterior wall (see Item B1 under INSULATION) and then airseal behind and around the tub before setting it — use plastic sheeting stapled and caulked or taped to the wood framing (Details B and C).
- ❑5. Seal all wiring, plumbing, and HVAC penetrations between conditioned and unconditioned spaces — at the top and bottom plates, through the ceilings, floors, and exterior walls, and other framing locations (Detail B).
- ❑6. Seal the wiring and knockout plugs in all electrical boxes and seal around all electrical boxes mounted on the exterior sheathing.
- ❑7. Seal windows and exterior doors into rough opening—backer rod preferred (Detail B).

B. During drywall installation

- ❑1. Seal the drywall to the bottom plate using construction adhesive or caulk.
- ❑2. Seal the drywall to the rough opening of windows and doors using construction adhesive or caulk.

C. After drywall is installed:

- ❑1. For houses with a crawlspace or basement seal, the bathtub drain and supply line penetrations through the floor after the tub is set and the plumbing is connected and before the floor insulation is installed — use

- rigid board insulation, plywood, or other sheet goods with caulk or spray foam (Detail C).
- ❑2. Seal plumbing pipes and electrical boxes (e.g., receptacles, outlets, switches, light fixtures, circuit breaker box) to the drywall or ceiling using painter's acrylic latex caulk or drywall mud — if possible, provide a surface-mounted circuit breaker box rather than inserting one into exterior wall framing (Detail B).
- ❑3. Install foam gaskets on all electrical boxes behind the cover plates.
- ❑4. Seal plumbing, medicine cabinets, and other penetrations (e.g., the electrical wire behind the kitchen range hood) to the drywall.
- ❑5. Seal exterior penetrations in the sheathing (e.g., porch light fixtures, outside outlets, phone, cable, electric service holes, faucet hose bib) if not sealed previously from inside the house.
- ❑6. Seal the bathroom ventilation fan housing to the ceiling drywall — use caulk or drywall mud (Detail B).
- ❑7. Seal between a masonry chimney and the attic framing — use sheet metal or other non-combustible sheet goods and high temperature (450°F), fire-rated caulk.
- ❑8. Seal attic bypasses and chases (e.g., open partition walls, dropped ceilings, duct and flue chases, kitchen cabinet soffits) before the attic insulation is installed using rigid board insulation, plywood, or other sheet goods with caulk or spray foam — if possible, construct these framing features after the ceiling is installed to avoid these attic bypasses.
- ❑9. For an attic access hatch cover located in a conditioned space, weatherstrip it (Detail I).
- ❑10. For an attic pull-down stair located in a conditioned space, weatherstrip it and provide a latch to hold the stair panel tightly against the weatherstripping.

- ❑11. For a whole-house fan, seal gaps around the whole-house fan frame — use spray foam (preferred) or housewrap tape (Detail E).
- ❑12. Fabricate whole house fan cover using rigid board insulation, contact paper, and velcro (Detail E).
- ❑13. Seal drywall and penetrations in the return duct plenum (if present) (mastic preferred or caulk) (Detail H).
- ❑14. Seal duct boots to floor or drywall (Detail D).
- ❑15. Verify that the HVAC contractor has sealed return and air supply duct connections (mastic required) and openings at the air handler (tape at access panels) (Details D and H).

Insulation

- ❑1. Select insulation levels that meet or exceed the 1995 Model Energy Code.
- A. For a slab foundation:**
- ❑1. Install rigid board insulation during slab construction around the perimeter of the slab using a code-approved method.
- ❑2. Install flashing as a termite shield.
- B. For a house with a crawlspace:**
- ❑1. Install floor insulation batts flush against the house floor (a vapor barrier is optional and, if present, should be installed following manufacturer's instructions).
- ❑2. Cut the floor insulation batts to the full length of the joist to be insulated.
- ❑3. Insulate the band joist to ensure complete coverage at the perimeter.
- ❑4. Slit the floor insulation batts to fit around wiring and plumbing (Detail A).
- ❑5. Insulate *between* air distribution system ducts and the floor as space permits.
- ❑6. Use insulation hangers (wire staves) spaced every 12-18 inches to hold the floor insulation in place without compressing the insulation more than 1 inch (Detail A).

C. For a house with a conditioned basement:

- ❑1. Insulate the basement walls by constructing an inside wall frame.

D. For the exterior walls:

- ❑1. Insulate the exterior walls around a bathtub before setting the tub (Detail C).
- ❑2. Insulate the exterior walls behind a stairwell and cover with sheet material before setting the stair stringers.
- ❑3. Cut wall insulation batts to the full length of the cavity to be insulated.
- ❑4. Cut wall insulation batts length-wise to fit into cavities with non-standard widths.
- ❑5. Slit wall insulation batts to fit around wiring, wall outlets and plumbing.
- ❑6. For cold and mixed climates, staple the kraft paper facing of wall insulation batts to the front of the studs (preferred) or sides of the studs (allow no more than ¼ inch compression) every 12 inches. In other climates, the kraft paper may need to face away from the interior, or an unfaced batt may be used (Detail A).
- ❑7. Insulate the band joist of a multistory home or a home with a conditioned basement.

E. For the attic:

- ❑1. Install attic rulers when using loose-fill insulation to ensure complete and full coverage.
- ❑2. If raised heel or oversized (cantilevered) trusses or a raised top plate are not used, install soffit dams and rafter guides before ceiling drywall is installed when using loose-fill insulation to provide a 1-inch clearance between the insulation and roof decking for attic ventilation and to obtain maximum attic insulation coverage over the exterior walls. Use commercial products, rigid board insulation, batt insulation or felt paper (Detail F and G).
- ❑3. Install blocking in the attic above a porch before ceiling drywall is

installed to prevent loose-fill insulation spillage into the porch soffit area — use rigid board insulation or other sheet goods.

- ❑4. Install a barrier around the attic access opening in the attic to ensure full insulation coverage when using loose-fill insulation — use an insulation batt, rigid board insulation, or other solid sheet good.

F. Insulate the attic access:

- ❑1. For an attic access hatch cover located in a conditioned space, glue 3-4 pieces of rigid board insulation and/or staple an insulation batt (R-15 or greater preferred) to the top of the cover (Detail I).
- ❑2. For an attic pull-down stairs located in a conditioned space, fabricate an insulated cover or use a commercial product — use rigid board insulation or fibrous ductboard.

G. For a whole-house fan:

- ❑1. Fabricate a whole-house fan cover — use rigid board insulation or fibrous duct board.

Sheathing

- ❑1. Repair any deficiencies in the exterior sheathing or exterior rigid board insulation.
- ❑2. Tape or caulk the sheathing seams or install house wrap.
- ❑3. Cover and seal the housewrap to the top and bottom plates and sills. Use house wrap tape or caulk (Detail J).
- ❑4. Cut diagonals for windows and doors and fold back to inside and staple (Detail J).
- ❑5. Overlap and seal housewrap seams. Use house wrap tape or caulk (Detail J).
- ❑6. Seal all cuts, penetrations, and openings in the housewrap — use housewrap tape or caulk (Detail J).
- ❑7. Use plastic capped nails or staples to mechanically fasten the housewrap to the house.

Windows

- ❑1. Select window types that meet or exceed the 1995 Model Energy Code.
- ❑2. Maximize glazing areas on the south walls.
- ❑3. Minimize unshaded glazing areas on the east and west walls in mixed and hot climates.
- ❑4. Use shade screens and tinting on windows facing south, east, and west in southern climates that are not already shaded by the roof, porch, vegetation, or other means.

A. *Window installation:*

- ❑1. Caulk the backside of the window flange to the sheathing during installation.
- ❑2. Seal windows into their rough opening. Use backer rod (preferred) or other insulating material with caulk, or use non-expanding spray foam.

Exterior Doors

- ❑1. Select door types that meet or exceed the 1995 Model Energy Code.
- ### **A. *Door installation:***
- ❑1. Seal between the door threshold and subflooring.
 - ❑2. Seal doors into their rough opening — use backer rod (preferred) or other insulating material with caulk, or use non-expanding spray foam.
 - ❑3. Adjust the door threshold properly for an air-tight fit.
 - ❑4. Install door weatherstripping.

Ventilation

A. *Kitchen range hood fan:*

- ❑1. Select a kitchen range hood fan with a flow rating of 100 - 150 cfm or more.
- ❑2. Vent the kitchen range hood fan directly to the outside through the roof or sidewall.
- ❑3. Make sure the damper in the kitchen fan is operating properly. The damper should be free swinging and should seal when the fan is off.

B. *Bathroom fan:*

- ❑1. Select a bathroom fan with a flow rate rating of at least 80 cfm at 0.1 inches of water gauge and a noise rating of no more than 1.5 sones - consider duct length in selecting the fan size.
- ❑2. Make sure a ventilation opening is cut in the roof for the bathroom fan before shingling.
- ❑3. Vent the bathroom exhaust fan directly to the outside through the roof or sidewall— use as short a run as possible.
- ❑4. Install the bathroom exhaust fan ducting as straight as possible, sloping the duct to the outside if a sidewall discharge is used.
- ❑5. Make sure the damper in the bathroom fan is operating properly — the damper should be free swinging and should seal when the fan is off.
- ❑6. Wire the bathroom fan and bathroom light to operate on the same switch (i.e., light on, fan on).

Equipment Closet

A. *If a gas furnace or water heater is being installed in a conditioned space, isolate the equipment closet from the conditioned space by:*

- ❑1. Insulating and sealing the combustion closet walls (Detail H).
- ❑2. Installing a solid (non-louvered) door with weatherstripping and a threshold (Detail H).
- ❑3. Sealing all gas, water line and electrical penetrations through the equipment closet (Detail H).
- ❑4. Providing two air inlets for combustion and venting for flue gases following code requirements (Detail H).

Heating and Cooling Equipment

- ❑1. Select heating equipment type after comparing operating and initial costs for all available fuel types.

- ❑2. Use higher-efficiency equipment when cost justified (typically in larger homes in more severe climates where fuel costs are high).
- ❑3. Size equipment using ACCA Manuals J and S.
- ❑4. Seal around the metal flue of combustion equipment — use a UL approved metal collar and high temperature (450°F), fire-rated caulk.
- ❑5. Install an outdoor thermostat on heat pumps to control auxiliary heat use.

Air Distribution System

- ❑1. Design an air-distribution (duct) system using ACCA Manual D.
- ❑2. Locate ducts inside the living area rather than the attic or crawl space.
- ❑3. Avoid using building cavities as part of the duct system.
- ❑4. Select ductwork insulation levels to meet or exceed the 1995 Model Energy Code.
- A. *Installation:***
- ❑1. Install ducts with proper support, without kinks or restrictions, and with a minimum number of bends and turns.
- ❑2. Connect all joints in the ductwork with mechanical fasteners.
- ❑3. Seal all joints in the ductwork with UL-approved duct sealing mastic — do NOT use cloth duct tape.
- ❑4. Seal the return duct plenum (e.g., sheet metal, floor joist panning, drywall) and any penetrations in the plenum — use mastic (preferred) or caulk (Detail D).
- ❑5. Seal duct boots to the floor or drywall (Detail D).
- ❑6. Seal connections and openings at the air handler — use mastic (preferred) for the return and supply duct connections, and use UL-181 duct tape at the filter, service, and other access panels (Detail H).

Water Heating

- ❑1. Consider fuel cost in selecting system type.

- ❑2. Use higher-efficiency equipment when cost justified (typically if hot water use and fuel costs are high).

A. *Installation:*

- ❑1. Seal around the metal flue of combustion equipment — use a UL approved metal collar and high temperature (450°F), fire-rated caulk.
- ❑2. Connect the hot and cold water pipes to the correct taps on the water heater.
- ❑3. Insulate the water heater tank with a jacket following manufacturer requirements (Detail K).
- ❑4. Install heat traps (inverted loops preferred or check valves) on both the hot and cold water pipes at the water heater (Detail K).
- ❑5. Insulate the first two feet of the hot and cold water pipes connected to the water heater (Detail K).
- ❑6. Set the water heater thermostat to 120°F.
- ❑7. For houses with a crawlspace (especially in cold and mixed climates), insulate the water pipes in the crawlspace for freeze protection.

Lighting

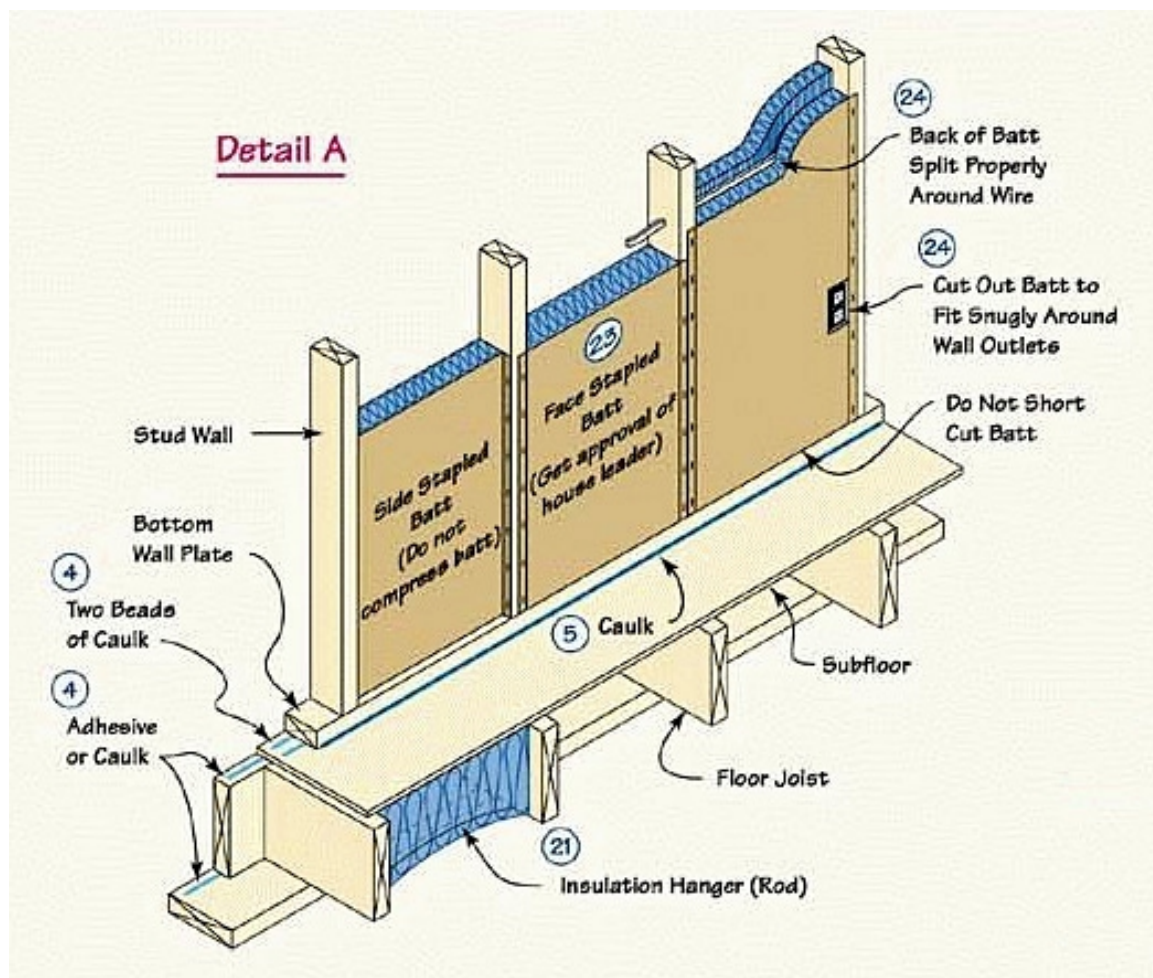
- ❑1. Install fluorescent light fixtures for area lighting that will be on for 4 hours or more each day — usually kitchens, hallways, and often bathrooms.
- ❑2. If recessed lights are installed in the ceiling with an unconditioned space above it, use only UL approved fixtures and rated Insulation Cover (IC) that meet ASTM E283 requirements, and seal between the fixture and the drywall.
- ❑3. Install fluorescent, high-pressure sodium, or metal halide fixtures for exterior lighting.
- ❑4. Use motion sensors or photo cells on exterior security lighting.

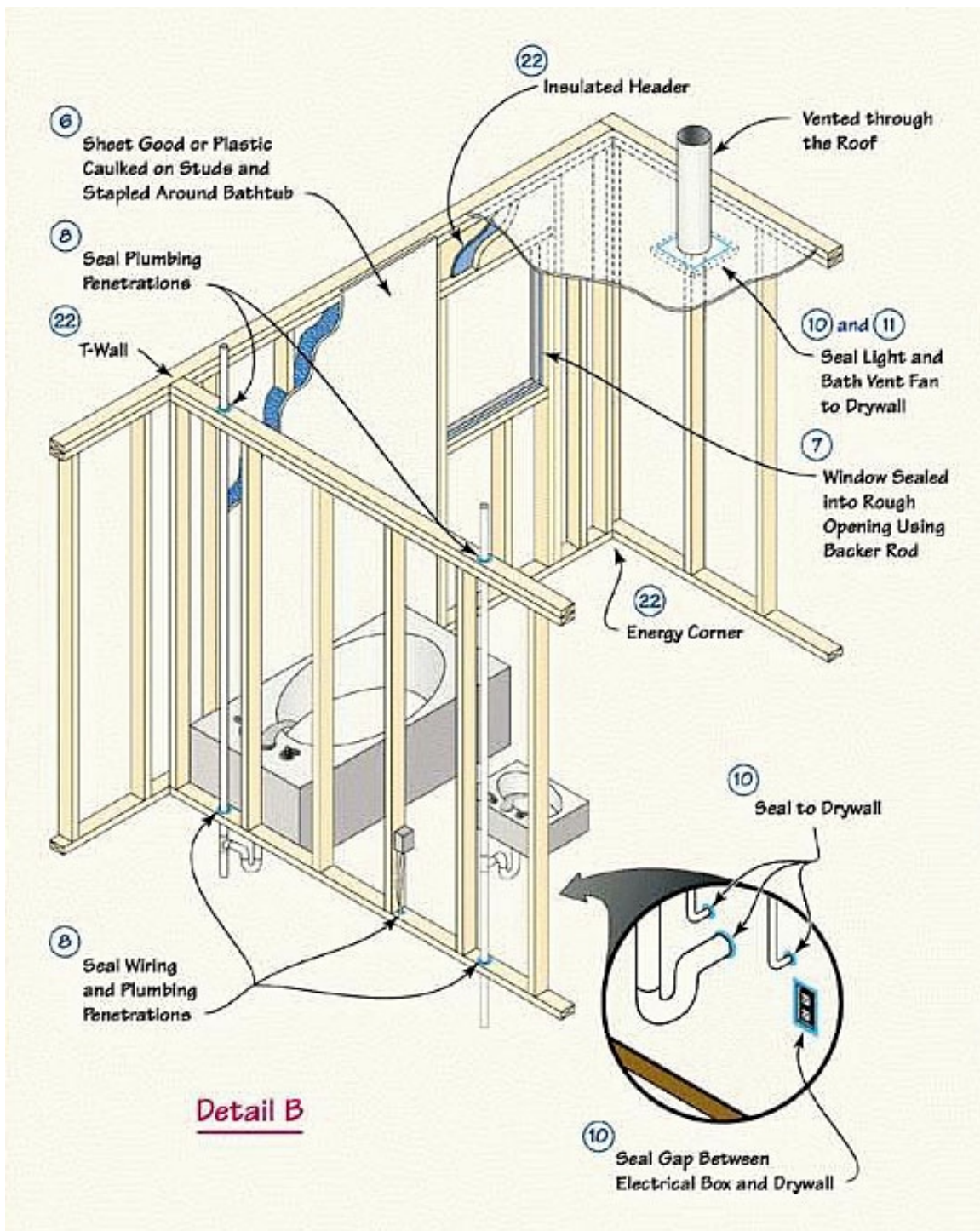
Appliances

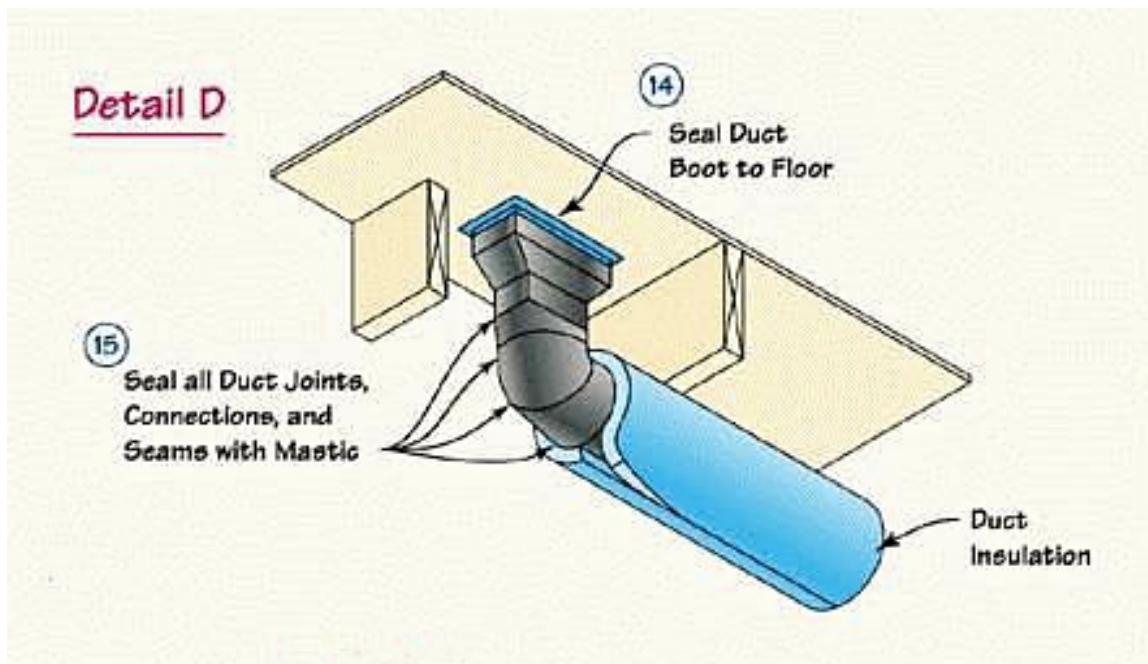
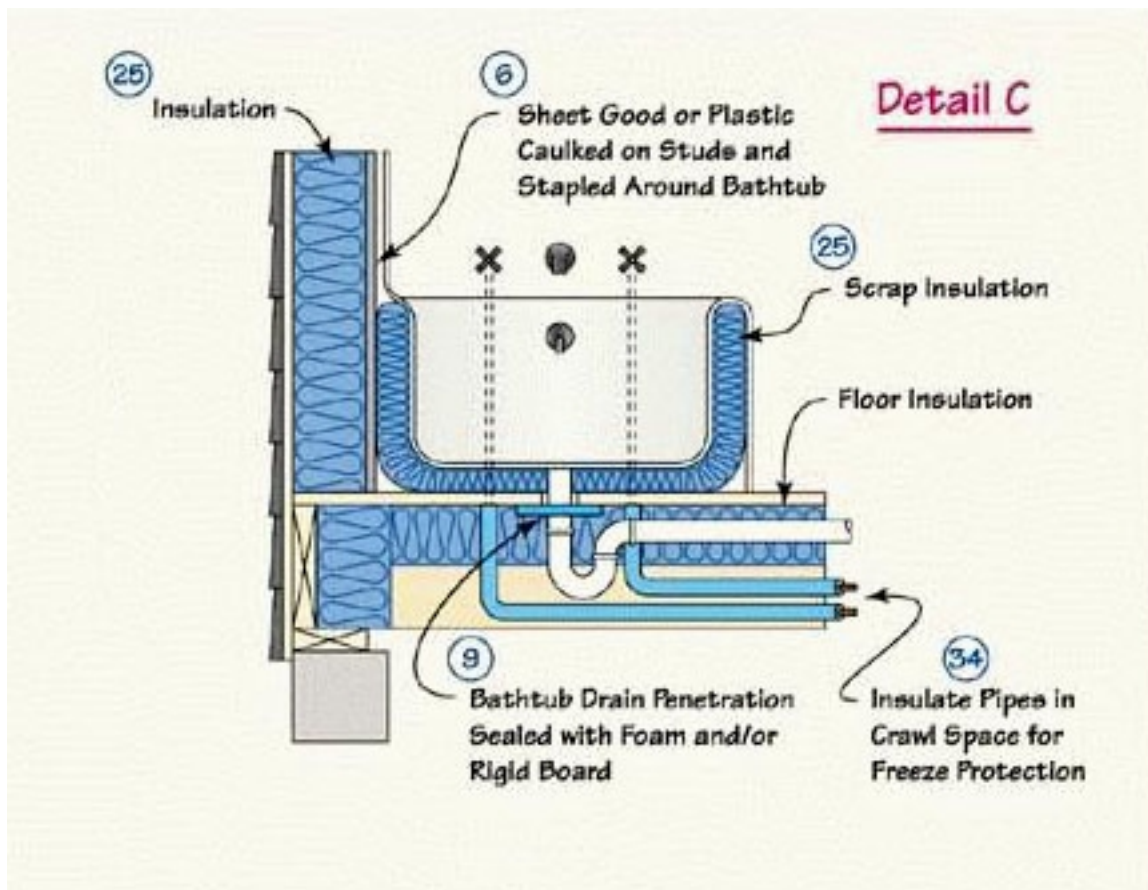
- ❑1. Select refrigerators, clothes washers and dishwashers that meet Energy Star requirements.

Adapted with permission from a factsheet (Residential Energy-Efficient Design and Construction Checklist) published by Oak Ridge National Laboratory, October 1999. Oak Ridge National Laboratory, P.O. Box 2008, Building 3147, Bethel Valley Road, Oak Ridge, Tennessee 37831-6070

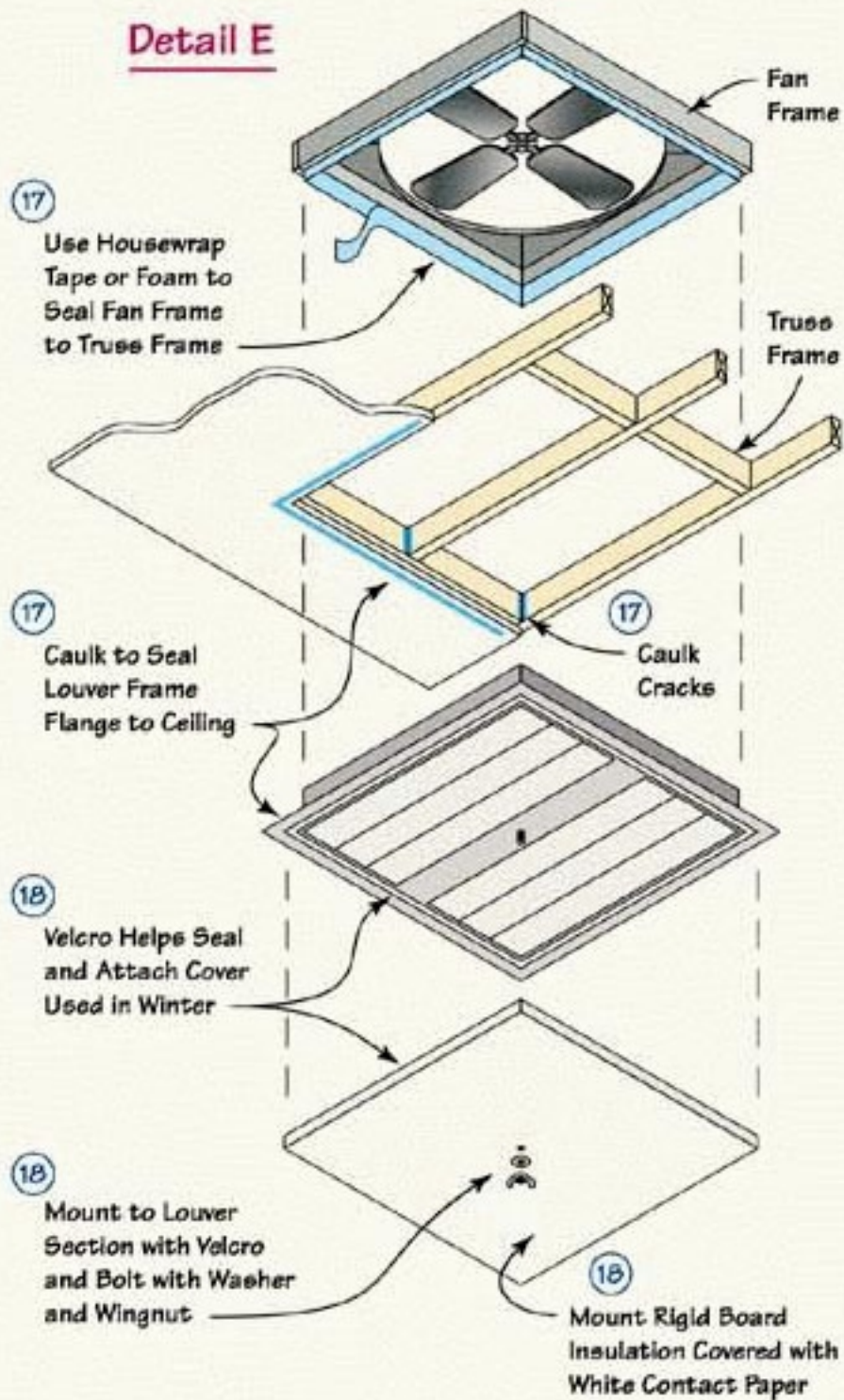
Adapted with permission from a factsheet (Habitat for Humanity Energy-Efficient Construction Checklist for Homes) published by U.S. Department of Energy, Office of Building Technology, State and Community Programs, 1000 Independence Avenue, Washington, DC 20585



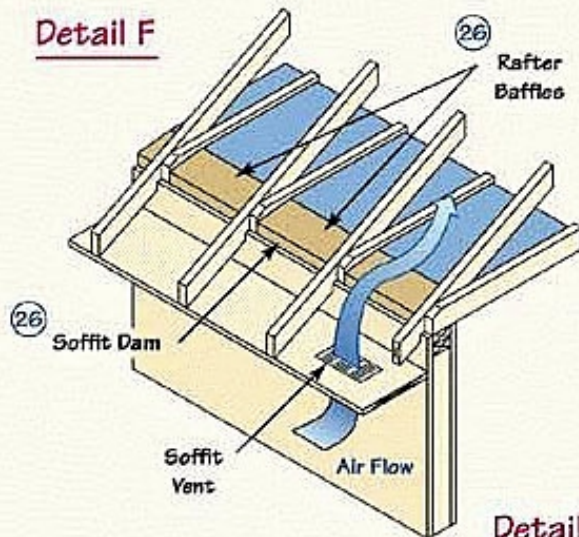




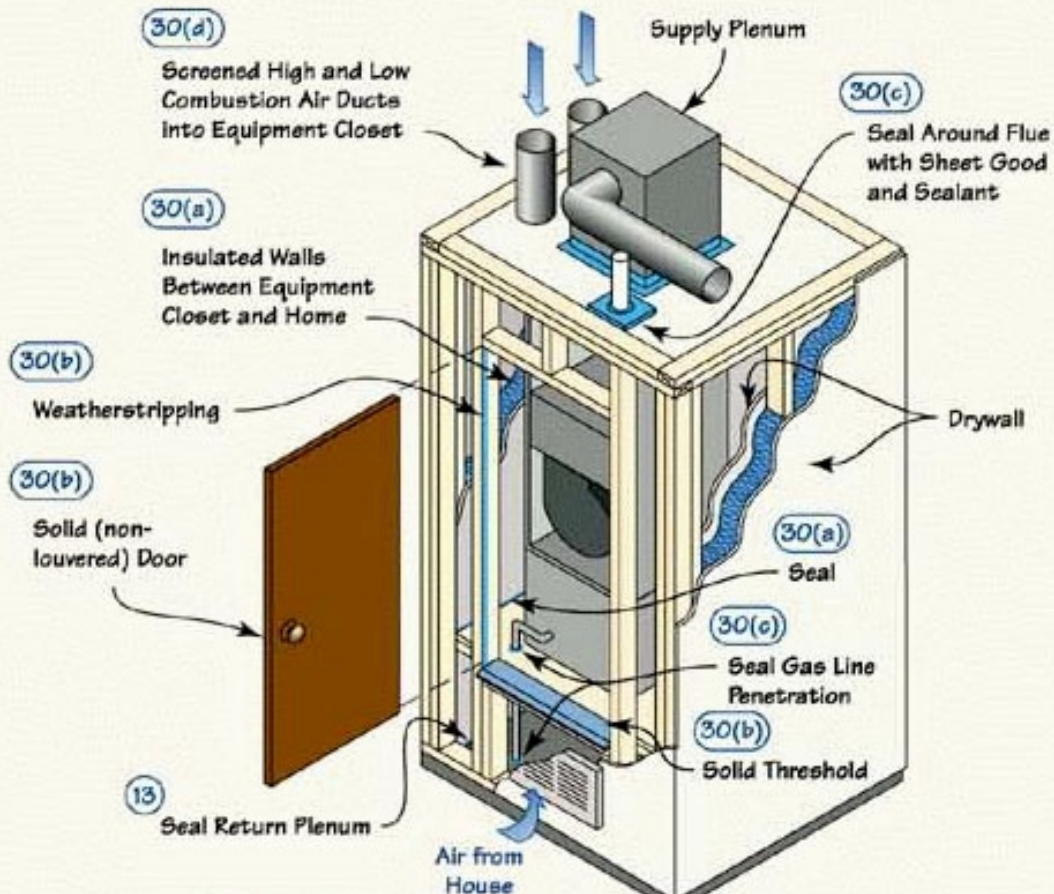
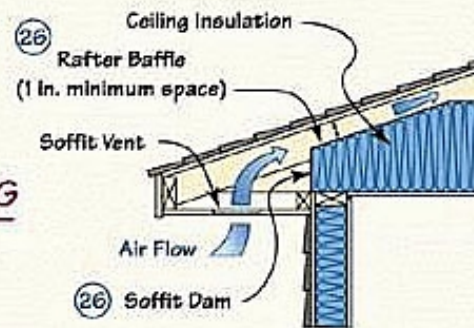
Detail E



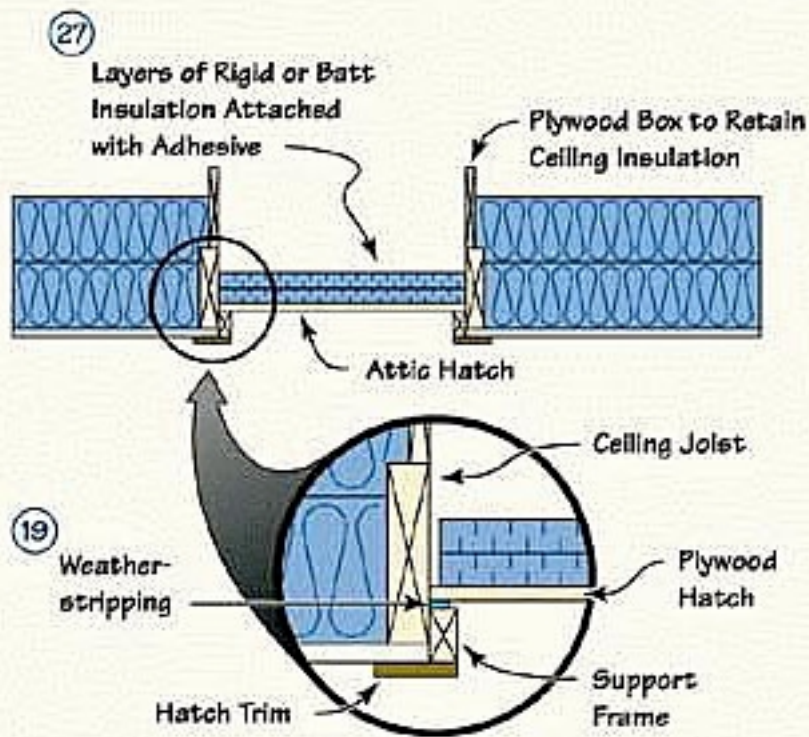
Detail F



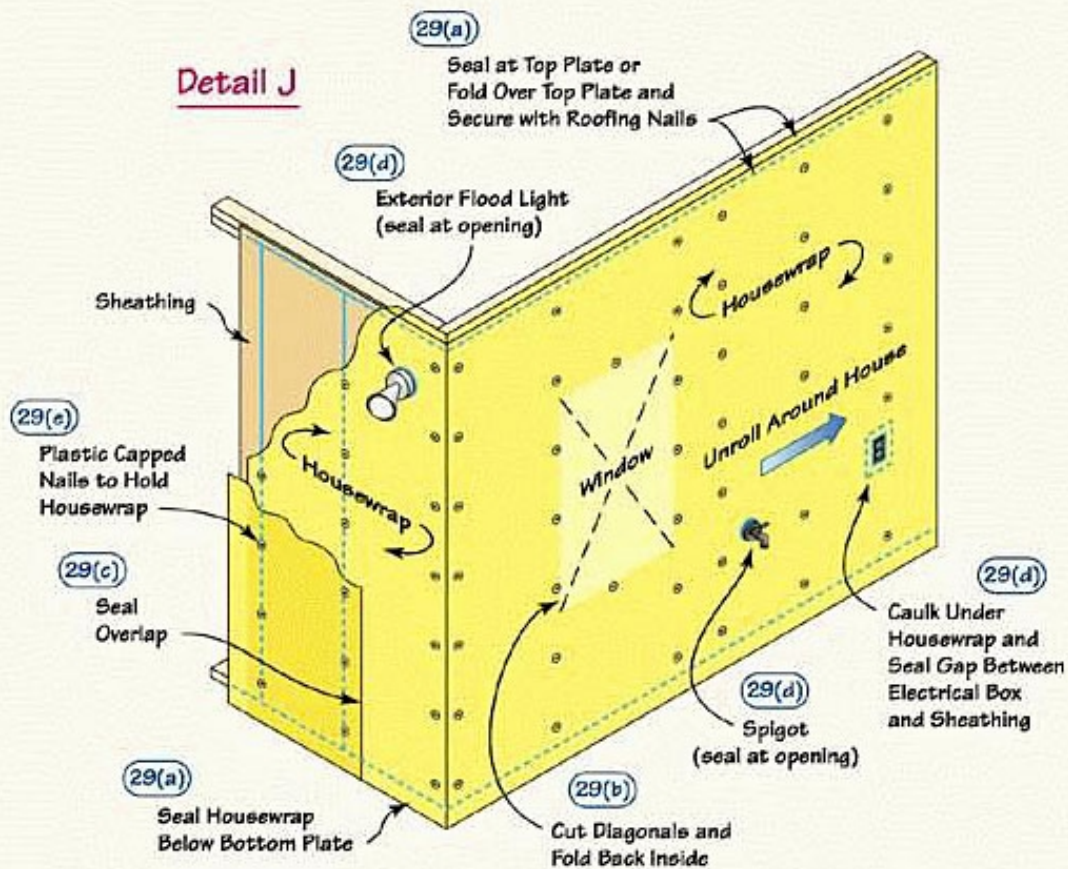
Detail G



Detail H



Detail I



Detail K

